

What is claimed is:

1 1. A system for determining a natural color depth of a digital image,
2 comprising:
3 a color distance module determining color distances between each pair of
4 colors in a color palette stored for a digital color image;
5 a merge module selecting a closest neighboring color for each color in the
6 color palette separated by a substantially minimum color distance, and merging,
7 in iterative sequence, each color pair that is visually indistinct.

1 2. A system according to Claim 1, further comprising:
2 an averaging module generating a weighted average of the colors in each
3 color pair that are visually indistinct.

1 3. A system according to Claim 2, wherein the weighted average z is
2 calculated, in accordance with the equation:

3
$$z = \frac{[count(x) \times x] + [count(y) \times y]}{count(x) + count(y)};$$

4 where x and y are the colors in the color pair, and $count()$ denotes the number of
5 occurrences of each color in the digital color image.

1 4. A system according to Claim 1, wherein visual distinctness is
2 determined based on an output of a function f of visual area, in accordance with
3 the equation:

4
$$f(x) = \frac{c}{x + c(y_2 - y_1)^{-1}} + y_1;$$

5 where x is a visual area occupied by one of the colors in the color pair, y_1 denotes
6 a horizontal asymptote, y_2 denotes a y -intercept, and c represents a fitted curve
7 constant.

1 5. A system according to Claim 4, further comprising:
2 a visualization module determining visual distinction Δ , in accordance
3 with the equation:

$$\Delta(x, y) = \begin{cases} \text{TRUE}, & \text{if } |x - y| \geq f(v(x)); \\ \text{FALSE}, & \text{if } |x - y| < f(v(x)); \end{cases}$$

where v is a visual area comprising a largest four-way block of contiguous pixels of one of the colors in the color pair.

6. A method for determining a natural color depth of a digital image, comprising:

determining color distances between each pair of colors in a color palette stored for a digital color image;

selecting a closest neighboring color for each color in the color palette

separated by a substantially minimum color distance; and

merging, in iterative sequence, each color pair that is visually indistinct.

7. A method according to Claim 6, further comprising:

generating a weighted average of the colors in each color pair that are visually indistinct.

8. A method according to Claim 7, further comprising:

calculating the weighted average z , in accordance with the equation:

$$z = \frac{[count(x) \times x] + [count(y) \times y]}{count(x) + count(y)};$$

where x and y are the colors in the color pair, and $count()$ denotes the number of occurrences of each color in the digital color image.

9. A method according to Claim 6, further comprising:

determining visual distinctness based on an output of a function f of visual area, in accordance with the equation:

$$f(x) = \frac{c}{x + c(y_2 - y_1)^{-1}} + y_1;$$

5 where x is a visual area occupied by one of the colors in the color pair, y_1 denotes
6 a horizontal asymptote, y_2 denotes a y -intercept, and c represents a fitted curve
7 constant.

1 10. A method according to Claim 9, further comprising:
2 determining visual distinction Δ , in accordance with the equation:

$$3 \quad \Delta(x, y) = \begin{cases} \text{TRUE}, & \text{if } |x - y| \geq f(v(x)); \\ \text{FALSE}, & \text{if } |x - y| < f(v(x)); \end{cases}$$

4 where v is a visual area comprising a largest four-way block of contiguous pixels
5 of one of the colors in the color pair.

1 11. A computer-readable storage medium holding code for performing
2 the method according to Claims 6, 7, 8, 9, or 10.

1 12. A system for reducing a color palette of a digital image to a natural
2 color depth, comprising:
3 a distance module selecting a neighboring color closest in color distance in
4 a color space for each unique color in the color palette of a digital image; and
5 a merge module merging the unique color and the closest neighboring
6 color, comprising determining visual distinctness of the unique color based on the
7 visual area occupied by the unique color in the digital image, and combining the
8 unique color and the closest neighboring color when visually indistinct and
9 reducing the color palette by replacing all occurrences of the unique color and the
10 closest neighboring color with the combined color.

1 13. A system according to Claim 12, wherein selecting the closest
2 neighboring color and merging the unique color and the closest neighboring color
3 is repeated until no further colors in the color palette merge.

1 14. A system according to Claim 12, further comprising:
2 a statistical module counting occurrences of the unique color, counting
3 occurrences of the closest neighboring color, and calculating a weighted average

4 of the unique color and the closest neighboring color to combine the unique color
5 and the closest neighboring color.

1 15. A system according to Claim 12, further comprising:
2 a visual distinctness module evaluating the visual area occupied by the
3 unique color relative to color distances in the color space from other colors to
4 determine a threshold below which the unique color and any other such color are
5 visually indistinct.

1 16. A system according to Claim 15, wherein visual distinctness is set
2 as occurring when the color distance between the unique color and the closest
3 neighboring color exceeds the threshold.

1 17. A system according to Claim 15, wherein the color distance is
2 determined as a Euclidean distance in the color space.

1 18. A system according to Claim 12, wherein the digital image is
2 received as an output from another color reduction process.

1 19. A system according to Claim 12, wherein the digital image is
2 forwarded as an input to another color reduction process.

1 20. A system according to Claim 12, further comprising:
2 a non-natural color depth color reduction process performing a color
3 reduction of the color palette of the digital image prior reducing the color palette
4 to a natural color depth.

1 21. A system according to Claim 12, further comprising:
2 a compression module compressing the digital image following reduction
3 of the color palette to a natural color depth.

1 22. A system according to Claim 12, wherein the color space is
2 selected from the group comprising CIELAB, RGB, sRGB, YUV, HSV, HSB,
3 and YCbCr.

1 23. A method for reducing a color palette of a digital image to a
2 natural color depth, comprising:
3 selecting a neighboring color closest in color distance in a color space for
4 each unique color in the color palette of a digital image; and
5 merging the unique color and the closest neighboring color, comprising:
6 determining visual distinctness of the unique color based on the
7 visual area occupied by the unique color in the digital image; and
8 combining the unique color and the closest neighboring color when
9 visually indistinct and reducing the color palette by replacing all occurrences of
10 the unique color and the closest neighboring color with the combined color.

1 24. A method according to Claim 23, further comprising:
2 repeatedly selecting the closest neighboring color and merging the unique
3 color and the closest neighboring color until no further colors in the color palette
4 merge.

1 25. A method according to Claim 23, further comprising:
2 counting occurrences of the unique color;
3 counting occurrences of the closest neighboring color; and
4 calculating a weighted average of the unique color and the closest
5 neighboring color to combine the unique color and the closest neighboring color.

1 26. A method according to Claim 23, further comprising:
2 evaluating the visual area occupied by the unique color relative to color
3 distances in the color space from other colors to determine a threshold below
4 which the unique color and any other such color are visually indistinct.

1 27. A method according to Claim 26, further comprising:

2 setting visual distinctness as occurring when the color distance between
3 the unique color and the closest neighboring color exceeds the threshold.

1 28. A method according to Claim 26, further comprising:
2 determining the color distance as a Euclidean distance in the color space.

1 29. A method according to Claim 23, further comprising:
2 receiving the digital image as an output from another color reduction
3 process.

1 30. A method according to Claim 23, further comprising:
2 forwarding the digital image as an input to another color reduction
3 process.

1 31. A method according to Claim 23, further comprising:
2 performing a color reduction of the color palette of the digital image prior
3 reducing the color palette to a natural color depth.

1 32. A method according to Claim 23, further comprising:
2 compressing the digital image following reduction of the color palette to a
3 natural color depth.

1 33. A method according to Claim 23, wherein the color space is
2 selected from the group comprising CIELAB, RGB, sRGB, YUV, HSV, HSB,
3 and YCbCr.

1 34. A computer-readable storage medium holding code for performing
2 the method according to Claims 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, or 33.